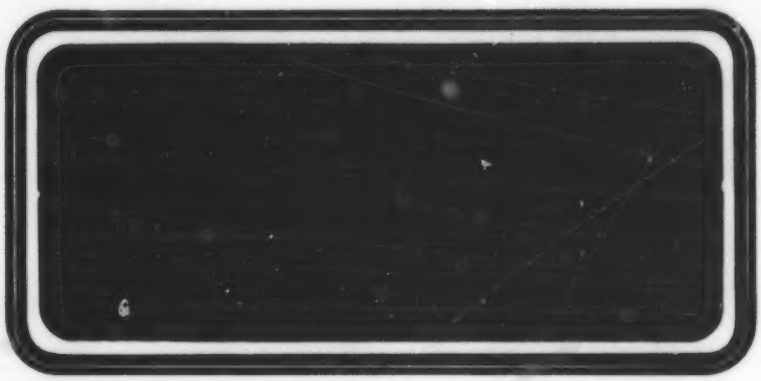
Canada Alberta

FOREST RESOURCE DEVELOPMENT AGREEMENT
ENTENTE SUR LA MISE EN VALEUR DES RESSOURCES FORESTIERES



Canada Alberta

The Canada-Alberta Forest Resource Development Agreement is a subsidiary agreement of the Canada-Alberta Economic and Regional Development Agreement, which provides coordination and cooperation between the governments of Alberta and Canada in areas of Alberta's economic development.

The Canada-Alberta Forest Resource Development Agreement is funded equally by the governments of Canada and Alberta, from April 1, 1984, to March 31, 1989.

Its primary objectives are to ensure the long-term availability of timber supplies; to optimize timber uses; and to contribute to the growth and diversification of Alberta's economy.

The Agreement comprises three programs: Reforestation; Applied research, technology transfer and opportunity identification; and Public information, evaluation and administration. These programs are managed by a joint Directorate and are implemented by Forestry Canada and the Alberta Forest Service.

L'Entente Canada-Alberta sur la mise en valeur des ressources forestières est auxiliaire à l'Entente Canada-Alberta sur le développement économique et régional, qui vise à assurer la coordination et la coopération des deux gouvernements relativement au développement économique de l'Alberta.

L'Entente Canada-Alberta sur la mise en valeur des ressources forestières est financée à parts égales par les gouvernements du Canada et de l'Alberta, et a cours du 1er avril 1984 au 31 mars 1989.

Ses objectifs principaux sont assurer la disponibilité à long terme de réserves de bois; optimiser leur utilisation; et contribuer à la croissance et la diversification de l'économie de la province.

L'Entente comprend trois programmes: Reboisement; Recherche appliquée, transferts de connaissances techniques et relevé des occasions; et Information, évaluation et administration. Ces programmes sont gérés par un Bureau de direction conjoint, et mis en oeuvre par Forêts Canada et le Service forestier de l'Alberta.

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EFFECT OF SCARF JOINTS ON BENDING PROPERTIES OF LAMINATED VENEER LUMBER

Forintek Canada Corp.[1]

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INTRODUCTION

The laminated veneer lumber industry is relatively new with a history of less than 20 years in large scale production. LVL was produced from Sitka spruce veneer and used in light weight aircrafts over 40 years ago (Luxford, 1944) but commercial production was not begun until early 1970's. Research in the past has shown many advantages of LVL over sawn lumber in terms of strength properties and allowable design stresses (Preston 1950 and Kunesh 1978). The production of LVL can also provide higher yields than obtainable from conventional sawing practices (Bohlem, 1972) because the material is peeled on a veneer lathe producing limited residuals. Strength reducing defects such as knots, holes and angled grain are dispersed and randomized through many veneer plies. This provides for more uniform strength properties and the opportunity of utilizing lower grade logs. Previous studies have been predominantly concerned with LVL made from Douglas-fir (Echols and Currier, 1973; Bohlen 1974; Bohlen 1975; and Kunesh 1978) and southern pine (Koch 1967; and Koch and Woodson 1968). However, there was no published reports on LVL made from the group of wood species, spruce, pine and fir.

The higher yield of LVL per unit log however does not offset the higher production costs due to higher capital investment, labor, intensity and heat energy consumption as compared with conventional sawmills (see Table 1). Therefore, it has been very difficult to compete economically with sawn lumber in commodity markets. It has been suggested that LVL has the best chance of penetrating primarily two types of markets (Younquist et Bryant, 1979).

1. Where parallel laminated veneer (PLV) material provides a reliable performing lumber substitute in sizes or grades that are unobtainable elsewhere and where price is a lesser consideration, and

2. Where the material can compete economically with expensive grades of solid sawn lumber or with proprietary LVL type products having high stress ratings.

At present, even the second type of market is questionable because there is plenty of high quality MSR lumber available in Western Canada. But it may become viable as the supply of large logs suitable for large dimension lumber is diminished further.

In view of the above facts, the growth of the LVL industry was slow in the 1970's but there has been a relatively rapid growth in the 1980's in North America. For the production of continuous or long LVL, there are currently five mills in production in the U.S. Trus Joist Corp. has two mills in Oregon, and one in Luisiana, Gang-Nail Systems has one in North Carolina and Arrowood Technologies Ltd. also has one in North Carolina. The main species used for LVL production are Douglas-fir in Oregon and Southern pine in the south. Norway spruce is used in Finland and marketed by McCausey in the U.S.

Since veneers come in finite lengths, nominally 8 ft. or 4 ft., end joints are required to form longer structural members. Scarf joints are commonly used in commercial production lines because they are easy to prepare, provide stronger joints than butt joints, and give a better appearance than lap joints. However, the effect of scarf joints on the flatwise bending strength is not well-known and the findings of a previous report (Jung, 1984) were questionable. In that report, it was found that the LVL with a scarf-joint in the face and bottom plies and butt joints in three core plies had a higher flatwise MOR than samples with scarf joints in all plies and had equivalent MOR to that of non-jointed LVL. Theoretically, the LVL with scarf joints must be weaker than material without any joints and scarf joints are known to be stronger than butt joints. Therefore, this present study was initiated to study the effect of scarf joints on the flatwise MOR of LVL.

EXPERIMENTAL

Aspen (Populus tremuloides) veneers used in this study were obtained from a plywood mill in Northern Ontario. They were nominally 102 in. long, 51.5 in. wide and 0.122 in. thick. The veneers obtained were classified as 'mill run', i.e., they were not graded either in the plywood mill or in the laminated veneer lumber mill. The veneer used was variable in quality and would generally receive a low grade. The majority of veneers were industrial and C grades according to Poplar Veneer Grades of CSA 0153-M1980. The veneer ends, except those for central plies were sawn to an acute angle to provide scarf joints for lamination.

An extended phenol-formaldehyde resin which was formulated for the production of Southern Yellow Pine LVL was applied as a single glueline with a spread rate of 41 lb/1000 ft^3 to the top surface of each veneer ply, except for the top veneer of the LVL plank. The veneers were placed so that the loose sides (the side with lathe checks) of every two adjacent veneers faced each other except for the central plies. The veneers were stacked mechanically to form a specially designed continuous layup pattern. The grain of all veneer sheets was maintained parallel to the length direction since the material was primarily intended to serve application requirements where strength, stiffness and dimensional stability in the length direction are of primary importance. The resinated veneers (except central plies) were end-jointed by a series of staggered scarf-joints formed in the laminating process. The central plies were placed so as to present a 1/8 in. gap between adjacent veneer ends to facilitate steam release during hot pressing.

Resinated veneer layups were pre-pressed then pressed in a 80 ft. semi-continuous hot press for a predetermined time at 325°F to form a continuous LVL plank. After each hot pressing cycle a pre-pressed layup was moved into the press for hot pressing forming a continuous LVL plank.

In order to determine the effect of scarf joints on the flatwise bending properties for the LVL's made from various plies of veneer, specimens were selected and planed down to remove as many plies as required. The specimens prepared can be summarized as follows:

10 13-ply specimens with no scarf joint in the tension side

10 13-ply specimens with a scarf joint in the middle of the tensile side

10 7-ply specimens with no scarf join in the tensile side

10 7-ply specimens with a scarf joint in the middle of the tensile side

10 5-ply specimens with no scarf joint in the tensile side

10 5-ply specimens with a scarf joint in the middle of the tensile side

For evaluation of joint performance, the flatwise bending was conducted by a two-point loading method to ensure that the joint was tested under a maximum bending moment. The minimum ratio of span to depth was 21. Both MOR and MOE were calculated and the ratio of the MOR for specimens with a scarf joint in the middle of the tensile side to the MOR of specimens without a joint in the middle of tensile side was calculated and expressed as a percentage. This percentage was used as an index of the effectiveness of scarf jointing.

RESULTS AND DISCUSSION

The results of this study are summarized in Table 2. As expected, scarf joints had little effect on the flatwise MOE of aspen LVL but had a significantly adverse effect on the flatwise MOR of aspen LVL. Table 2 shows that the MOR of 5- and 13-ply LVL was reduced 28 percent and the MOR of 7-ply LVL was reduced 18 percent when a scarf joint was present in the middle of tensile side of the bending specimen i.e., under the maximum bending moment. In other words, the effectiveness of scarf joint in terms of flatwise MOR was only 72 to 82 percent. It should be noted that the effectiveness of scarf joints was not dependent on the thickness of LVL in this study. It is presumed that the 7-ply specimens without a scarf joint in the middle of tensile side was simply weaker than both 13- and 5-ply specimens. Table 2 also shows that the MOR's of all three different thicknesses (number of plies) of LVL are not significantly different. This suggests that the stress concentration at the two ends of the overlap in a single scarf joint dominates the flatwise bending failure of scarf-jointed LVL when the joint is situated under the maximum bending moment. There is a suspicion that the tips of the scarf were so thick (about 1/32 in.) that the stress concentration at the ends of joint may cause a great deal of local stresses, weakening the joint.

CONCLUSIONS AND RECOMMENDATIONS

The main conclusion of this study is that scarf joints reduce flatwise MOR significantly but do not affect flatwise MOE significantly.

For certain applications, the strength of LVL is critical and thus a further study is recommended to consider techniques of improving the joint strength.

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Table 1

Economic Factors for LVL Relative to Conventional Sawmill Systems

Cost Factor	Relative Factor	
	Conventional Lumber	LVL
Capital ($/MBF)	1	2.95
Yield (MBF lumber/ton of logs)	1	1.34
Labor (hrs./MBF of product)	1	1.47
Heat Energy (BTU/MBF of product)	1	1.48
Electrical Energy (kwh/MBF of product)	1	0.17

Source: Tillman, D.A. 1985

Table 2

Effect of Scarf Joint on the Flatwise Bending Properties of Three Different Thicknesses of Aspen Laminated Veneer Lumber (LVL)

Nominal Thickness in.	Number of Veneer Plies	Scarf[a] Joint	MOE (cv) 10^3 psi (%)	MOR (cv) psi (%)	Relative[b] Effectiveness
1 1/2	13	No	1.903 (4.3)	11366 (10.3)	1
	13	Yes	1.857 (4.6)	8181 (7.5)	0.72
13/16	7	No	1.771 (7.8)	10367 (13.1)	1
	7	Yes	1.765 (6.9)	8509 (12.2)	0.82
9/16	5	No	1.984 (5.3)	12549 (13.1)	1
	5	Yes	1.967 (6.7)	8991 (16.1)	0.72

[a] Scarf joint in the middle of the tensile side

[b] In terms of MOR